

POWER SUPPLY INTERFACE:  
REMOTE SERIAL FIBER OPTIC LINK

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This document outlines the interface details of a circuit which implements the protocol for a local serial fiber optic link. The serial link is bi-phase mark encoded with a 5Mbit per second bit rate. The circuit consists of a fiber optic transmitter/receiver pair, a FIFO, the control circuitry, and a delay line. The control circuitry handles both the receiver and transmitter functions. Two distinct control circuits exist: the Waveform Generator Interface and the Remote Interface.

## 1.0 Introduction

The Waveform Generator communicates with the Remote Interface via a pair of low cost serial fiber optic links. The Waveform Generator calculates a Setpoint Value (setpoint) and transmits the setpoint frame to the Remote Interface via the fiber optic link. At the Remote Interface, this frame is simultaneously clocked into the output register and the FIFO. Once a valid setpoint frame has been detected, the transmitter on the Remote Interface will be enabled to "loopback" the setpoint frame by clocking each individual bit of the received frame out of the FIFO. This "loopback" frame is transmitted exactly as received without recalculating the CRC check word. In addition to the "loopback" frame, each Remote Interface has the provision of transmitting one of two groups of four readbacks (the primary group or the secondary group), selectable by the Waveform Generator, for a total of five frames transmitted to the Waveform Generator. In addition, each Remote Interface has the option of disabling the select, whereby only the primary group will be transmitted. Each of the remaining four frames will be transmitted in succession following the loopback frame. Frames are only transmitted to the Waveform Generator in response to receiving a setpoint frame from the Waveform Generator.

Upon power up of the Waveform Generator, a re-synchronizing frame will be sent. The purpose of this frame is to phase synchronize the Waveform Generator's transmitter and the Remote Interface's receiver. Both the setpoint frame and the resynchronizing frame are synchronous with the 720 Hz RHIC Timeline Event.

Three applications presently exist for the implementation of Remote Interface: the RHIC Main Magnet Power Supplies (24

bits), a low precision (10-12 bits) analog interface, and a medium precision (16 bits) digital interface.

## 2.0 Frame Format

A fixed length frame of 43 bits is used for the Waveform Generator and the Remote Interface transmissions. When frames are not transmitted, the idle state of the link is a continuous stream of ones. Each frame consists of the following bits and fields:

- Start bit (zero)
- 8-bit type field
- 24-bit data field
- 8-bit crc error check ( $x^8+x^7+x^5+x^4+x+1$  generating polynomial, excluding start/stop bits)
- 2- Stop bits (ones)

All signals described in this document are defined as TTL Logic 1 = +5V.

### 2.0.1 Type Field

#### 2.0.1.1 Waveform Generator

The 8 bits are defined as follows:

bit 7	msb	frame type (setpoint or readback)
bit 6		readback group select (A or B)
bit 5		x
bit 4		x
bit 3		x
bit 2		x
bit 1		x
bit 0	lsb	x

Bit 7 is always set to 0 to signify a setpoint frame. The only controllable bit is bit 6 : group A (primary) or group B (secondary) select. The other bits in the type field are hard coded.

re-sync frame	00	(00000000)
setpoint (Programmed I)		
group A select	21	(00010101)
group B select	85	(01010101)

#### 2.0.1.2 Remote Interface

The 8 bits are defined as follows:

bit 7	msb	frame type (setpoint or readback) (msb)
bit 6		readback group select (A or B)
bit 5		readback channel # msb
bit 4		readback channel # lsb
bit 3		remote error
bit 2		Bipolar (BP)/ Unipolar (UP/)
bit 1-0	lsb	undefined

Bit 7 is always set to 1 to signify a readback frame. Bits 5 and 4 will be set by the Remote Interface to signify which of the four channels is being sent. Bit 3 is set to signify that one of the following errors occurred: no End of Convert (EOC) signal from the ADC, a frame error on the received frame, or a crc error on the received data. Bit 2 is set if the data format is to be 2's complement and cleared if it is to be straight binary. The state of this bit is jumper selectable.

#### 2.0.1.2.1 RHIC Main Magnet Power Supplies

Group Selection will be disabled via a jumper so that bit 6 is always a 0 to ensure only readbacks from the primary group, regardless of the state of bit 6 sent from the Waveform Generator. This is to guarantee that the RTDL Input Module receives a parameter value for each trigger event. The coding for bits 5 and 4, and the corresponding type field code assuming no errors is as follows:

		bit5	bit4	type field
channel 0	Measured I	0	0	128 (10000000)
channel 1	Measured V	0	1	144 (10010000)
channel 2	Measured I dot	1	0	160 (10100000)
channel 3	undefined	1	1	176 (10110000)

If any of the above errors occurs, bit 3 will be set to a 1 and the Waveform Generator should not process that particular frame.

#### 2.0.1.2.2 Low Precision Analog Interface

At this time, the only function of the Remote Interface that is implemented is the Setpoint receiver. The "loopback" and readback functions are not utilized. Readbacks are acquired solely through the MADC System.

### 2.0.1.2.3 Medium Precision Digital Interface

Bit 6 is controlled from the Waveform Generator, and identifies one group of four frames out of a possible two groups. The primary group of readbacks will be sent most of the time with the option to send a secondary "diagnostic" group. The coding for bits 5 and 4, and the corresponding type field code assuming no errors is as follows:

Primary Group: bit 6 = 0.

		bit5	bit4	type field
channel 0	Measured I	0	0	128 (10000000)
channel 1	Measured V	0	1	144 (10010000)
channel 2	I <sub>b</sub> (Hall)	1	0	160 (10100000)
channel 3	Error I	1	1	176 (10110000)

Secondary group: bit 6 = 1.

		bit5	bit4	type field
channel 0	Reference I	0	0	192 (11000000)
channel 1	75% Cal.	0	1	208 (11010000)
channel 2	25% Cal.	1	0	224 (11100000)
channel 3	Field B	1	1	240 (11110000)

### 2.0.2 Data Field

The Waveform Generator setpoint field and Remote Interface readback field use all 24 bits in the data field. The data within this field is left justified 2's complement.

bit 23	sign bit
bit 22	msb data
bits 21-1	data
bit 0	lsb data

## 3.0 Interface requirements

Interface requirements for the Waveform Generator and the Remote Interface are described below.

### 3.0.1 Waveform Generator

The Waveform Generator will provide the following signals:

Setpoint Data	(24)
Group A/B select	(1)
Setpoint Load	(1)

Trigger Xmit (1)

The following signals will be provided to the Waveform Generator:

Readback Type Field (4)  
Remote Error (1)  
Readback Data (24)  
Data Valid (1)  
CRC Error (1)  
Frame Error (1)  
BP/UP/ (1)

### 3.0.2 Remote Interface

The following signals will be provided to the Remote Interface:

Readback Data (24)  
Error (EOC) (1)  
DAVAIL (1)  
Group A/B Disable (1)  
BP/UP/ (1)

The following signals will be provided by the Remote Interface:

Setpoint data (24)  
Mux Address (3)  
RDBAKEN (1)  
Xmit BUSY (1)  
Load (1)  
Valid (1)  
FRMERR (1)  
CRCERR (1)

The Medium Precision Digital Interface includes a Data Acquisition Control and Timing gate array.

## 4.0 Functionality

### 4.0.1 Waveform Generator

#### 4.0.1.1 Transmitting

One 24 bit register will be provided for loading the setpoint. An active low LOAD pulse, SETPTLD, is necessary to latch the

data into the register on the rising edge. In addition, the transmission of the setpoint frame will occur when a TRIGXMIT pulse has been received from the Waveform Generator Module. The Type field will be hard coded, except for the Group A/B select bit.

#### 4.0.1.2 Receiving

Readback frames from the Remote Interface will be provided via a 4-bit type field register and a 24-bit data field register. Upon successful decoding of a valid frame from the Remote Interface, a DATA VALID will be issued. Loopback information will also be provided via these same two registers. In addition, a FRAME ERROR signal and a CRC ERROR signal will be provided. An ERROR bit decoded from the type field frame will be provided to flag the occurrence of an error at the remote end. The BP/UP/ bit will determine how to interpret the incoming data.

#### 4.0.2 Remote Interface

##### 4.0.2.1 Transmitting

Loopback of the setpoint will be accomplished by providing the decoded serial bit stream directly to the encoder section of the transmitter. In this way, the data will be sent back exactly as received without calculating a new crc checkword. After the successful reception of a frame (LOAD = 1), the loopback function starts, and the XMIT BUSY bit will be set to a 1 to signify that the transmitter is in the process of sending a frame. Upon completion of the loopback function, data will be strobed into the transmit section via RDBACKEN and transmitted. The MUX address will be incremented to the next channel, digitized, latched and transmitted to The Waveform Generator. This will continue until all channel data has been sent at which time XMIT BUSY bit will be set to a 0. Readbacks are only transmitted when a setpoint frame has been received. Should a channel fail to finish digitizing (no End of Convert), digitization will be aborted and the error bit of the type field (bit 3) will be set to a 1.

##### 4.0.2.2 Receiving

Each frame received will contain an 8-bit type field and a 24-bit data field. A LOAD pulse will be generated when it has been determined that the received frame has the correct header and trailer information, as well as the correct number of

bits. This pulse will be issued regardless of the internal data integrity. A VALID pulse will be generated when a frame has been received with no errors. On the occurrence of both the LOAD and VALID pulses, the 24-bit setpoint can be latched. If a FRAME or CRC error occurs, the new setpoint will not be latched and bit 3 for all of the transmit type fields will be set to a 1. The "loopback" data will be transmitted regardless of the status of the FRAME or CRC error bits.